Detection of peanut traces in wheat flour through NIR hyperspectral imaging spectroscopy

Puneet Mishra[1], Pilar Barreiro[1] , Jean Michel Roger[2], Belén Diezma[1]
Ana Herrero-Langreo[2], Lourdes Lleó[1], Nathalie Gorretta[2]

[1]LPF-TAGRALIA, UPM-CEI Moncloa. ETSI Agrónomos, Avda Complutense s/n. 28040, Madrid, Spain
[2] Irstea, UMR ITAP, 361 Rue J.F. Breton, 34196 Montpellier Cedex 5, France

INTRODUCTION

Peanut (*Arachis hypogaea*), a common economical food source consumed worldwide, is an increasing concern regarding allergenic effects and their influence on human health. Use of common environment for processing different powder foods in the industry has increased the risk of finding peanut traces in powder foods. Peanut are the leading cause of fatalities from food-induced allergenic reactions, being avoidance the primary management of these allergies.

OBJECTIVE

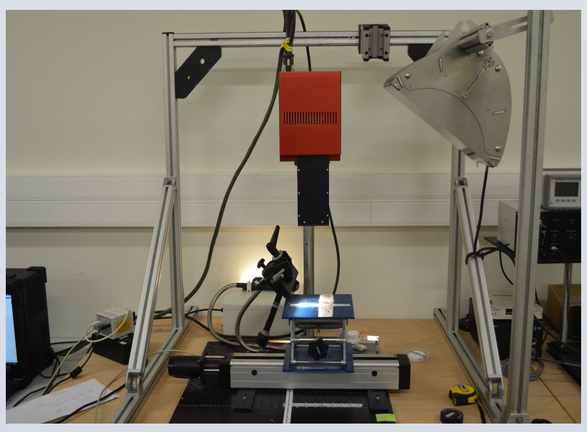
The objective of the present work was to evaluate the feasibility of HSI for the detection and quantification of peanut traces in wheat flour. For such purpose, different samples of commercial flour adulterated with peanut traces (10 % to 0.01 % by weight) were made with reference peanut samples obtained from European Commission´s Institute for Reference Materials and Measurements.

MATERIAL AND METHODS

Sample preparation:

- Wheat flour (125-100 and 212-160 µm), "Coeur de Blé" from manufacturer MasterChef
- Peanut (500-1000 µm) : obtained from European Commission Institute for Reference Materials and Measurements (IRMM-481kit) .
- KERN 770 analytical weighing balance
- Aluminum platforms (36 cm^2 and 95 cm^2) (Fig. a.)
- Eleven samples were made: pure peanut, pure wheat flour, samples with wheat flour and known position of peanut on the surface and eight homogeneously mixed samples from 10% to 0.01% of peanut by weight

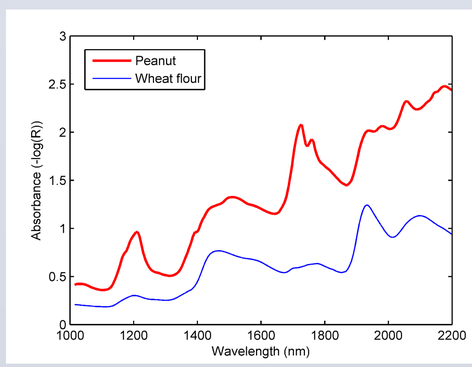
a. Platform for spreading the sample



b. Hy-spex HSI system

Camera setup:

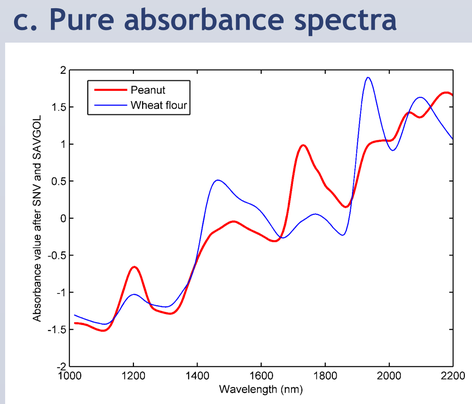
- HySpex SWIR-320m-e line-scan push broom camera by *Norsk* Elektro Optikk, Norway
- Spectral range: 1000 - 2500 nm, sampling gap 6 nm, spatial pixels per line 320
- Halogen light source
- Diffuse reflectance standard by SPECTRALON® (Labsphere, France)



c. Pure absorbance spectra

Pre-processing of hyperspectral data:

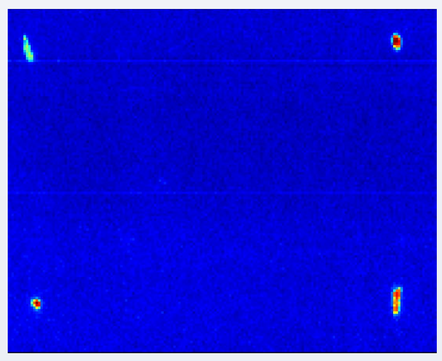
- Absorbance spectra was used for processing $-\log_{10}(R)$ (Fig. c.)
- *Standard Normal Variate* (SNV) and *Savitzky-Golay* (15 point window with second order polynomial, no derivative): to reduce environmental and texture effects (Fig. d.)



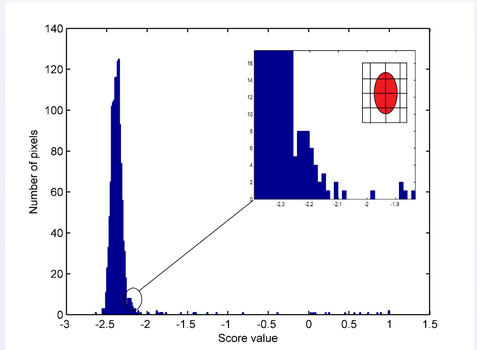
d. Spectra after pretreatments

Data analysis:

- Principal Component Analysis (PCA) with dataset of pure peanut and wheat flour
- PCA loadings were applied to images
- Images of scores were threshold according to the histogram to obtain classification images



e. Score image used to decide threshold

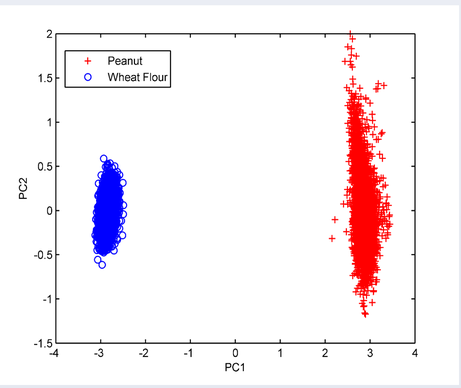


f. Histrogram obtained for thresholding

RESULTS

PCA results:

- PCA analysis presented 99.43 % of the variance by two main PC : PC1 98.38 % and PC2 1.05 %
- PC1 presented clear differentiation between peanut and wheat flour
- Variability within products is mainly represented in PC2

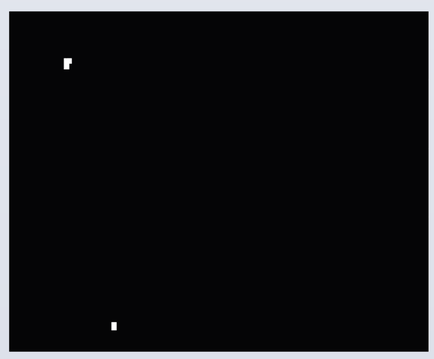


g. Scores plot

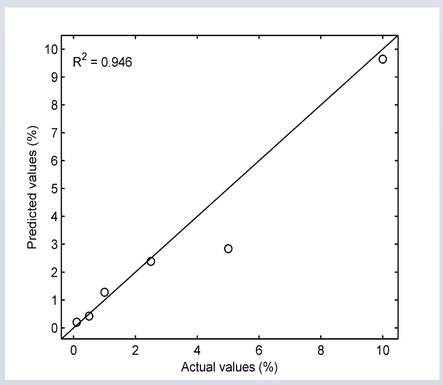
Score and classification images:

- Application of PC1 loading helped in enhancing contrast between the peanut and wheat flour pixel.
- After thresholding enhanced contrast images, classification images provide clear detection and quantification of peanut.

h. Score image for 0.01 % traces



i. Classification image for 0.01 % traces



j. Correlation plot

Correlation plot:

- A correlation R^2 = 0.946 was found between actual and estimated peanut levels for the samples down till 0.1 %
- quantification did not seems to be reliable for detection below 0.1 %

CONCLUSIONS

- NIR Hyperspectral images (1000-2200 nm) allowed the detection of peanut traces down to adulteration percentages 0.01%
- Determination coefficient of R^2=0.946 was found for the quantification of peanut adulteration from 10% to 0.1%.
- The obtained results shows the feasibility of using HSI systems for the detection of peanut traces in conjuction with chemical procedures, such as RT-PCR and ELISA to facilitate quality control surveyance on food product processing lines.

ACKNOWLEDGEMENT

The authors are grateful for peanut samples sets used in the work provided by European Commission Joint Research Centre, Institute for Reference Materials and Measurements and travel grant provided by Campus of International Excellence, Moncloa.